UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/975,297	10/12/2001	Viatcheslav V. Ossipov	10007286-1	1278

7590 03/27/2003

HEWLETT-PACKARD COMPANY
Intellectual Property Administration
P.O. Box 272400
Fort Collins, CO 80527-2400

EXAMINER
SOWARD, IDA M

ART UNIT	PAPER NUMBER
2822	

DATE MAILED: 03/27/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/975,297	Applicant(s) OSSIPOV ET AL.	
	Examiner Ida M Soward	Art Unit 2822	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *28 February 2003* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-14 and 21-33* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-14 and 21-33* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

This Office Action is in response to the Applicant's remarks filed February 28, 2003.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-3, 6-8 and 12 are rejected under 35 U.S.C. 102(b) as being anticipated by Nakagawa et al. (5,985,708).

Nakagawa et al. teach an electron emitter 41 comprising : a p region 49; a dielectric layer 70 formed above the p region; a metallic layer 71-73 formed above the dielectric layer; means (terminal) for emitting electrons through the metallic layer; an n+ region 63 formed above a substrate such that the p region is formed within the n+ region; the substrate being below the p region; the p region being formed from a semiconductor; a p electrode formed above and making electrical contact with the p region; an M electrode (end of terminal) formed above and making electrical contact with the metallic layer; an electron concentration level of the n+ region being greater than a hole concentration level of the p region as noted by the plus sign of the n+

region; and an n electrode formed above and making electrical contact with the n+ region (Figures 12-17, cols. 16-18, all lines).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 4-5 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakagawa et al. (5,985,708) as applied to claims 1-3, 6-8 and 12 in view of van Gorkom et al. (4,325,084).

Nakagawa et al. teach all mentioned in the rejection above. However, Nakagawa fail to teach a semiconductor including at least one of Si, Ge, GaP, InP, InGaAs, and InGaP; a hole concentration level of the p region ranging substantially between 1016 and 1019 com-3. van Gorkom et al. teach an electron emitter comprising: Si semiconductor material; a p region **3** formed of a semiconductor material having a hole concentration of 10^{19} cm^{-3}; an Al metallic layer **8** formed above the dielectric layer (Figures 2-3, cols. 6-7, lines 20-49 and 31-44, respectively). Since Nakagawa et al. and van Gorkom et al. are from the same field of endeavor (electron emitter structures), the purpose disclosed by van Gorkom et al. would have been recognized in the pertinent art of Nakagawa et al. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electron emitter of Nakagawa

et al. by incorporating the semiconductor material and hole concentration of van Gorkom et al. to obtain extra acceleration energy of the electrons (abstract).

Claims 14-17, 20, 24-25, 28 and 32-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakagawa et al. (5,985,708) and van Gorkom et al. (4,325,084) as applied to claims 1-8 and 12-13 in view of Kusunoki et al. (US 2001/0017515 A1).

Nakagawa et al. and van Gorkom et al. teach all mentioned in the rejection above. However, Nakagawa et al. and van Gorkom et al. fail to teach at least one voltage biasing source is connected such that the electrons tunnel through a dielectric layer 12 prior to passing to the metallic layer (Figure 1, pages 4-1, paragraphs [0063], [0065] & [0073]). Also, it is within the level of ordinary skill to apply negative and positive potential on a particular region of a semiconductor device. Since Nakagawa et al., van Gorkom et al. and Kusunoki et al. are from the same field of endeavor (electron emitter structures), the purpose disclosed by Kusunoki et al. would have been recognized in the pertinent art of Nakagawa et al. and van Gorkom et al. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electron emitter of Nakagawa et al. and the semiconductor material and hole concentration of van Gorkom et al. by incorporating the biasing source of Kusunoki et al. to improve electron emission efficiency (abstract).

Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakagawa et al. (5,985,708) and van Gorkom et al. (4,325,084) as applied to claims 1-8 and 12-13 above, and further in view of Morishita (5,140,400).

Nakagawa et al. and van Gorkom et al. teach all mentioned in the rejection above. However, Nakagawa et al. and van Gorkom et al. fail to teach an n+ region formed from materials with wider band gap than a p region. Morishita teaches an n+ region formed from materials with wider band gap than a p region (col. 10, lines 16-37). Since Nakagawa et al., van Gorkom et al. and Morishita are from the same field of endeavor (electron emitter structures), the purpose disclosed by Morishita would have been recognized in the pertinent art of Nakagawa et al. and van Gorkom et al. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electron emitter of Nakagawa et al. and the semiconductor material and hole concentration of van Gorkom et al. by incorporating with the n+ wider band gap of Morishita to prevent undesired diffusion current (abstract).

Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakagawa et al. (5,985,708) and van Gorkom et al. (4,325,084) as applied to claims 1-8 and 12-13 above, and further in view of Bronner et al. (US 6,242,770 B1).

Nakagawa et al. and van Gorkom et al. teach all mentioned in the rejection above. However, Nakagawa et al. and van Gorkom et al. fail to teach a fail to teach a p region thickness less than a diffusion length of non-equilibrium electrons in the p region. Bronner et al. teach a p region thickness of 0.05 μm to about 0.2 μm, which is less than

a diffusion length of non-equilibrium electrons in the p region (col. 5, lines 5-15). Since Nakagawa et al., van Gorkom et al. and Bronner et al. are from the same field of endeavor (electron emitter structures), the purpose disclosed by Bronner et al. would have been recognized in the pertinent art of Nakagawa et al. and van Gorkom et al. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electron emitter of Nakagawa et al. and the semiconductor material and hole concentration of van Gorkom et al. by incorporating the p region thickness of Bronner et al. to occupy a lesser wafer area (col. 3, lines 5-8).

Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakagawa et al. (5,985,708) and van Gorkom et al. (4,325,084) as applied to claims 1-8 and 12-13 above, and further in view of Ishio et al. (US 200/0014705 A1).

Nakagawa et al. and van Gorkom et al. teach all mentioned in the rejection above. However, Nakagawa et al. and van Gorkom et al. fail to teach a fail to teach fail to teach a metallic layer thickness on the order of or less than a mean free path for electron energy. Ishio et al. teach a metallic layer thickness of 3nm to 1μm which is on the order of or less than a mean free path for electron energy [0095]. Since Nakagawa et al., van Gorkom et al. and Ishio et al. are from the same field of endeavor (electron emitter structures), the purpose disclosed by Ishio et al. would have been recognized in the pertinent art of Nakagawa et al. and van Gorkom et al. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electron emitter of Nakagawa et al. and the semiconductor material and

hole concentration of van Gorkom et al. by incorporating the metallic layer thickness of Ishio et al. to ensure high connection reliability (abstract).

Claims 18 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakagawa et al. (5,985,708), van Gorkom et al. (4,325,084) and Kusunoki et al. (US 2001/0017515 A1) as applied to claims 1-8 and 12-13 above, and further in view of Morishita (5,140,400).

Nakagawa et al., van Gorkom et al. and Kusunoki et al. teach all mentioned in the rejection above. However, Nakagawa et al., van Gorkom et al. and Kusunoki et al. fail to teach an n+ region formed from materials with wider band gap than a p region. Morishita teaches an n+ region formed from materials with wider band gap than a p region (col. 10, lines 16-37). Since Nakagawa et al., van Gorkom et al., Kusunoki et al. and Morishita are from the same field of endeavor (electron emitter structures), the purpose disclosed by Morishita would have been recognized in the pertinent art of Nakagawa et al., van Gorkom et al. and Kusunoki et al. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electron emitter of Nakagawa et al., the semiconductor material and hole concentration of van Gorkom et al. and the biasing source of Kusunoki et al. by incorporating the n+ wider band gap of Morishita to prevent undesired diffusion current (abstract).

Claims 19 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakagawa et al. (5,985,708), van Gorkom et al. (4,325,084) and Kusunoki et al. (US 2001/0017515 A1) as applied to claims 1-8 and 12-13 above, and further in view of Bronner et al. (US 6,242,770 B1).

Nakagawa et al., van Gorkom et al. and Kusunoki et al. teach all mentioned in the rejection above. However, Nakagawa et al., van Gorkom et al. and Kusunoki et al. fail to teach a fail to teach a p region thickness less than a diffusion length of non-equilibrium electrons in the p region. Bronner et al. teach a p region thickness of 0.05 μm to about 0.2 μm, which is less than a diffusion length of non-equilibrium electrons in the p region (col. 5, lines 5-15). Since Nakagawa et al., van Gorkom et al., Kusunoki et al. and Bronner et al. are from the same field of endeavor (electron emitter structures), the purpose disclosed by Bronner et al. would have been recognized in the pertinent art of Nakagawa et al., van Gorkom et al. and Kusunoki et al. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electron emitter of Nakagawa et al., the semiconductor material and hole concentration of van Gorkom et al. and the biasing source of Kusunoki et al. by incorporating the p region thickness of Bronner et al. to occupy a lesser wafer area (col. 3, lines 5-8).

Claims 21 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakagawa et al. (5,985,708), van Gorkom et al. (4,325,084) and Kusunoki et al.

(US 2001/0017515 A1) as applied to claims 1-8 and 12-13 above, and further in view of Ishio et al. (US 200/0014705 A1).

Nakagawa et al., van Gorkom et al. and Kusunoki et al. teach all mentioned in the rejection above. However, Nakagawa et al., van Gorkom et al. and Kusunoki et al. fail to teach a fail to teach a metallic layer thickness on the order of or less than a mean free path for electron energy. Ishio et al. teach a metallic layer thickness of 3nm to 1μm which is on the order of or less than a mean free path for electron energy [0095]. Since Nakagawa et al., van Gorkom et al., Kusunoki et al. and Bronner et al. are from the same field of endeavor (electron emitter structures), the purpose disclosed by Bronner et al. would have been recognized in the pertinent art of Nakagawa et al., van Gorkom et al. and Kusunoki et al. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electron emitter of Nakagawa et al., the semiconductor material and hole concentration of van Gorkom et al. and the biasing source of Kusunoki et al. by incorporating the metallic layer thickness of Ishio et al. to ensure high connection reliability (abstract).

Claims 22 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakagawa et al. (5,985,708), van Gorkom et al. (4,325,084) and Kusunoki et al. (US 2001/0017515 A1) as applied to claims 1-8 and 12-13 above, and further in view of Song (6,153,014).

Nakagawa et al., van Gorkom et al. and Kusunoki et al. teach all mentioned in the rejection above. However, Nakagawa et al., van Gorkom et al. and Kusunoki et al. a fail to teach a dielectric breakdown field of $1.5 * 10^7 \leq F_b \leq 2 * 10^7$ V/cm. Song teaches a dielectric breakdown field of $1.04 * 10^7$ V/cm (col. 7, lines 7-11). Since Nakagawa et al., van Gorkom et al., Kusunoki et al. and Bronner et al. are from the same field of endeavor (semiconductor technology), the purpose disclosed by Bronner et al. would have been recognized in the pertinent art of Nakagawa et al., van Gorkom et al. and Kusunoki et al. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electron emitter of Nakagawa et al., the semiconductor material and hole concentration of van Gorkom et al. and the biasing source of Kusunoki et al. by incorporating the dielectric breakdown field of Song to provide a uniform layer (col. 7, lines 7-11).

Claims 23 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakagawa et al. (5,985,708) and van Gorkom et al. (4,325,084) as applied to claims 1-8 and 12-13 above, and further in view of Song (6,153,014).

Nakagawa et al. and van Gorkom et al. teach all mentioned in the rejection above. However, Nakagawa et al. and van Gorkom et al. fail to teach a fail to teach a dielectric breakdown field of $1.5 * 10^7 \leq F_b \leq 2 * 10^7$ V/cm. Song teaches a dielectric breakdown field of $1.04 * 10^7$ V/cm (col. 7, lines 7-11). Since Nakagawa et al., van Gorkom et al. and Song are from the same field of endeavor (semiconductor technology), the purpose disclosed by Song would have been recognized in the

pertinent art of Nakagawa et al. and van Gorkom et al. Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electron emitter of Nakagawa et al. and the semiconductor material and hole concentration of van Gorkom et al. by incorporating the dielectric breakdown field of Song to provide a uniform layer (col. 7, lines 7-11).

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

The following patents are cited to further show the state of the art with respects to electron emitters:

Fox et al. (5,952,772)

Kim (5,908,699)

Kishino et al. (6,040,587)

Kusunoki et al. (5,936,257)

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ida M. Soward whose telephone number is 703-305-3308. The examiner can normally be reached on Monday - Thursday, 6:30 am to 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on 703-308-4905. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

ims
March 20, 2003

AMIR ZARABIAN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800